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Some issues of analysis structural complex systems

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Abstract: *The article deals with the analysis of indicators of structurally complex systems, the structure of which can be displayed as a network graph. An example of bringing a system with a complex structure to a recurrent form is given.*

Key words: *system, structure, function, model, graph.*

Modern systems are characterized by a large number of elements and complex connections. The functional purpose of such systems is diverse. Some systems can be designed to perform critical, sometimes especially important tasks.

When developing such large systems with a complex structure and a large number of elements, the analysis of the quality of the systems being developed at the design stage is of particular importance. This will allow early warning of possible project errors. For this purpose, a mathematical model of the developed system is being built. To simplify the process of building a system model and analysis, it is assumed that the functioning of system elements are independent and have no memory [1] and cannot be restored [2-11].

Models of systems with a simple structure in the form of a serial or parallel connection of elements are not complicated. Such systems perform their function F(X), provided that the assigned functions are fulfilled by the elements of the system x_i.

$$F(X)=f(x_1)\ \wedge f(x_2)\wedge f(x_3).....\wedge f(x_n), \qquad (1)$$

where n is the number of elements of the system under study, f (x_i) is a function of the ith element, or, in short,

$$F(X)= \wedge f(x_i), \qquad (2)$$

where ^, depending on the nature of the system under study, can have the form Π,∑, or alternate.

When analyzing the reliability of a system with a sequential structure, function (2) has the form

$$F(X)= \prod_{i=1}^{n} f(x_i) \qquad (3)$$

For systems with a parallel structure

$$F(X)=1- \prod_{i=1}^{n} 1-f(x_i) \qquad (4)$$

In mobility systems of the “k of n” type, the system is considered operable when at least "k" of its elements are operable. Let N denote the set of system elements, the number of operable elements by n, then

$$F(X)= 1 \quad for \quad n \geq к. \qquad (5)$$

With homogeneous system elements

$$F(X)=\prod_{i=1}^{n} f(x_i), \text{ where } x_i\in N \text{ и } n \geq к. \quad (6)$$

Suppose that the set of elements of the system N can be divided into j subsets. For each subset, its own condition “k of n”' is defined. Under these conditions, (5) takes the form

$$F(X)=\prod_{r=1}^{j} \prod_{i=1}^{kr} f(x_{i,r}), \qquad (7)$$

where x_i, r - i-element of r -th subset.

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Most of the problems of analyzing systems with a complex structure are simplified by transforming the structure of the system to an ordered, recurrent form [7-9]. As an example, most authors [1,2,3] consider the bridge structure

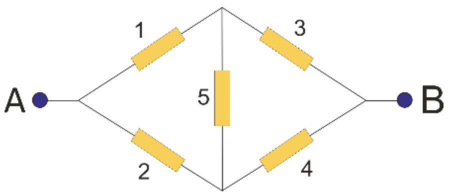

Fig. 1

where A - system input, B - system output.

To simplify the elements of the system, we replace the edges of the graph, their connections by nodes.

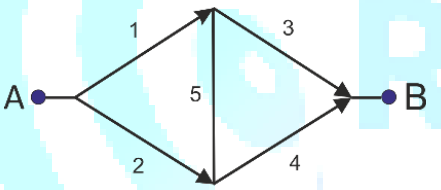

Fig. 2

The system is considered to be efficient if there is at least one path between the input of system A and the output of system B. In many cases [1,2,3] the authors propose algorithms for transforming the structural model of complex systems into parallel-sequential ones, by the method of finding the minimum paths. The shortest path is called such a connection of the minimum number of system elements that ensures the operability of the system.

For the given example, the number of minimum paths is 4:

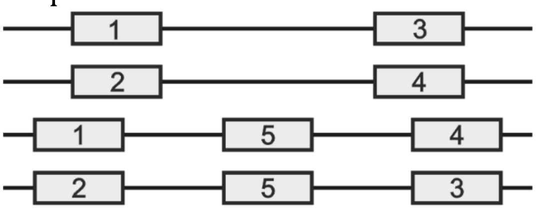

Fig. 3

It is known [1,7,8,12] that the calculated value of F (X) by the minimum path method gives an estimate of its maximum value F (X). With an increase in the number of elements in the system, the process of finding the minimum paths increases.

In [8], it is proposed to replace element 5 of the bridge system with two oppositely directed ribs

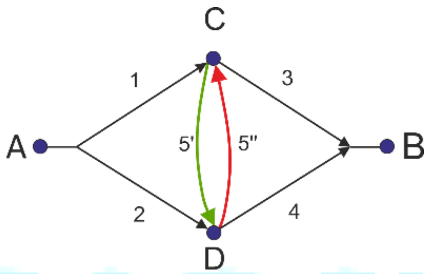

Fig. 4

In reliability problems, the edges 5' and 5" are assigned the value of element 5. To bring the structure of the system under consideration to a recurrent form, it is necessary to bifurcate the nodes C and D and connect them with edges.

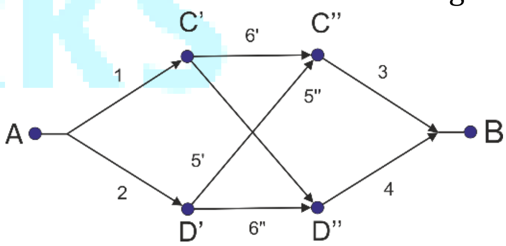

Fig. 5

Edges 6'and 6" must be assigned a value that does not affect the desired system value. In reliability problems, 1 is assigned. The transformed system has a recurrent structure, the edges are directed from the input to the output of the system. The resulting structure can be divided into consistently interconnected subsystems. In our example, there are 3 subsystems.

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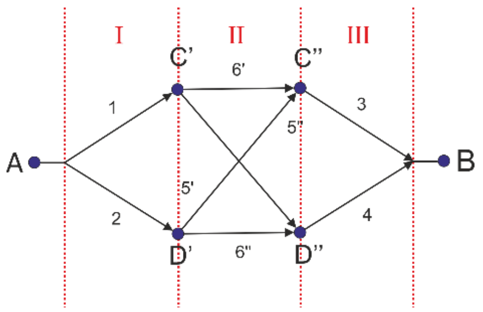

Fig. 6

The process of dividing into subsystems is called the ranking of the system. Accordingly, we number the subsystems in ascending order from input to output. In systems with a recurrent structure, the input signal of the system is the input signal of the elements of the first rank. The output signals of the elements of the first rank are input for the elements of the second rank and further. In our example, elements 1 and 2 are assigned to the first rank subsystem.

For elements of the second rank 5’, 5”', 6’, 6”, the input signal is formed from the output signals of the elements of the first rank. The output of the elements of the last rank is the output of the system. Algorithms for converting input signals into outputs for each subsystem must be specified and they can be different.

The structure of the system under study, reduced to a recurrent form, makes it possible to greatly simplify the process of analyzing indicators of an initially structurally complex system.

List of references:

1. Batrakov P.A. et al. Algorithm for transforming the structural model of a complex system into a parallel-serial one. Omsk Scientific Bulletin. No. 34,2013.
2. Levin V.I. Logical methods in the theory of reliability of complex systems. TSU Bulletin, vol. 16, issue 6, 2011.
3. Mayer A.V. An automated software package for modeling the reliability of complex systems. TSU Bulletin, No. 6, 2009.
4. Ryabinin I.A. Reliability and safety of structurally complex systems. SPb. Publishing house of SPbU. 2007.
5. Ryabinin I.A. Cherkesov G.N. Logical probabilistic methods for investigating the reliability of systems with a complex structure. Radio and communications, 1981.
6. Reinschke K. Ushakov I.A. Assessing the reliability of systems using graphs. M. Radio and communication, 1988.
7. Boyko I.A. Reliability of functional civil aviation systems. Selected Works of the Russian School on Science and Technology. RAS. M. 2008.
8. Nechiporenko V.I. Structural analysis of systems. Efficiency and reliability. M. Soviet radio, 1977.
9. Severtsev N.A. Dar'ina A.N. Application of similarity criteria for resource processing of complex technical systems and products. Sat Reliability and quality of complex systems. Penza GU №4 2020.
10. Hansler E. A fast recursive algoritm to calculate the reliability of communicationnetwork. IEEETrans. Commun. June 1972 Com-20 # 3.
11. Normatov R.N. To the analysis of the structural reliability of complex systems. In the book. Cybernetics. Tashkent, Institute of Cybernetics and Computing Center of the Academy of Sciences of the Uzbek SSR, 1977, issue 99.
12. Esary J.D. Proshan F. Coherent Structures of non –Identical Components. Technometrics, Vol.5, # 2, May 1962.
13. Tukhtasinova, O. Y. "Occasional Words Speech Unit." *International Journal on Integrated*

Education, vol. 3, no. 8, 2020, pp. 107-111, doi:10.31149/ijie.v3i8.542.
14. Sheptunov M.V. Boiler houses as informatized objects of protection in terms of reliability and safety of structurally complex systems. Risk analysis problems, vol. 15, no. 1, 2018.
15. Tukhtasinova O. Y. Lexical Occasionalisms And Its Relation To Related Phenomena //The American Journal of Social Science and Education Innovations. – 2020. – Т. 2. – №. 08. – С. 103-109.
16. Ed Bullmore, Olaf Sporns. Complex brain networks: graph theoretical analysis of structural and functional systems. https://warwick.ac.uk/fac/sci/dcs/research/combi/seminars/bullmoresporns_complexbrainnetwork_nrn2009.pdf